AF-4

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Madhav Datta et al.

Title: DUAL-STACK, BALL-LIMITING METALLURGY AND METHOD OF MAKING SAME

Docket No.: 884.523US1
Filed: September 21, 2001
Examiner: Erik Kielin

Serial No.: 09/961,036
Due Date: May 14, 2005
Group Art Unit: 2813

**MS Appeal Brief - Patents**
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

We are transmitting herewith the following attached items (as indicated with an "X"):

X A return postcard.
X Appellants' Brief on Appeal, including Appendices (26 Pages).
X Authorization to charge Deposit Account No. 19-0743 in the amount of $500 for Appeal Brief Fee.

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SCHWEGMAN, LUNDBERG, WOESSNER & KLUTH, P.A.
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By: Ann M. McCrackin
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John D. Gustav-Wrathall
Name

Signature

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(GENERAL)

PATENT

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

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| In re Application of: | | ) | |
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| Madhav Datta et al. | | ) | Examiner: Erik Kielin |
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| Serial No.: | 09/961036 | ) | Group Art Unit: 2813 |
| | | ) | |
| Filed: | September 21, 2001 | ) | Docket: 884.523US1 |
| | | ) | |
| For: | DUAL-STACK, BALL-LIMITING METALLURGY AND METHOD OF MAKING SAME | | |

## APPELLANTS' BRIEF ON APPEAL

Mail Stop Appeal Brief- Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The Appeal Brief is presented in support of the Notice of Appeal to the Board of Patent Appeals and Interferences, filed concurrently herewith, from the Final Rejection of claims 17-19, 21, 23, and 25 of the above-identified Application, as set forth in the Final Office Action mailed on September 13, 2004.

Pursuant to 37 C.F.R. 41.37(a), this Appeal Brief is submitted singly. The Commissioner of Patents and Trademarks is hereby authorized to charge Deposit Account No. 19-0743 in the amount of $500.00 which represents the requisite fee set forth in 37 C.F.R. § 41.20(b)(2). The Appellants respectfully request reconsideration and reversal of the Examiner's rejections of the pending claims.

# APPELLANTS' BRIEF ON APPEAL

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## 1. REAL PARTY IN INTEREST

The real party in interest of the above-captioned Application is the Assignee, Intel Corporation.

## 2. RELATED APPEALS AND INTERFERENCES

In accordance with 37 CFR §41.37(c)(1)(ii) requiring identification of all other appeals and interferences which would have any bearing on the Board's Decision in the present Appeal, to the best knowledge of Appellant, there have not been and are not any other Appeals, and no Interferences, based on the subject application.

## 3. STATUS OF THE CLAIMS

In accordance with 37 CFR § 41.37(c)(1)(iii) requiring a statement of the status of all claims, pending and cancelled, Appellant submits the following:

Claims 1-45 have been advanced during the prosecution history of the application, except for claims 1-16, which have been cancelled. Claims 20, 22, 24, and 26-45 have been withdrawn from consideration under several restriction requirements. In any event, claims 17-45 and are pending.

Claims 17-19, 21, 23, and 25 stand finally rejected under 35 USC §103. Claims 17-19, 21, 23, and 25 have been rejected and/or have been given a final rejection, and accordingly, the jurisdictional prerequisite under 37 CFR §1.191 for Appeal from the Decision of the Examiner to the Board of Patent Appeals and Interferences has been met. In view of the requirements under 37 CFR §1.191 that an Appeal in an application or reexamination preceding identify, when the Appeal is taken, all rejected claim or claims which are to be appealed and proposed to be contested, Appellant respectfully submits that all presently rejected claims (Claims 17-19, 21, 23, and 25) are appealed.

## 4. STATUS OF AMENDMENTS

The following is a statement of the status of any Amendments filed subsequent to final rejection (as required by 37 CFR §41.37(c)(1)(iv)).

No amendments have been made subsequent to the Final Office Action dated September 13, 2004.

## 5. SUMMARY OF CLAIMED SUBJECT MATTER

A concise explanation of the claimed embodiments defined in the claims in the Appeal, which refers to the specification by page and line number and to the drawings by reference characters (as required by 37 CFR §41.37(c)(1)(v))is detailed as follows.

A claimed embodiment includes a process. Reference can be made to FIGs. 3-9 and to independent claim 17 for illustration of a summarized embodiment.

The process includes forming a metallization (14). The process further includes forming a refractory metal first layer (26) over the metallization (14). The process further includes forming a refractory metal second layer (28) over the refractory metal first layer (26). The process further includes forming a refractory metal third layer (30) above and on the refractory metal second layer (28), and the refractory metal third layer (30) is substantially the same metal as the refractory metal first layer (26). The process further includes forming a refractory metal fourth layer (32) above and on the refractory metal third layer (30), and the refractory metal fourth layer (32) is substantially the same metal as the refractory metal second layer (28). Subsequently, the process includes forming an electrically connective bump (42) above the refractory metal fourth layer (32).

## 6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

In accordance with 37 CFR §41.37(c)(1)(vi)), the following is a concise statement of each ground of rejection presented for review.

Claims 17, 19, 21, 23, and 25 were rejected under 35 USC §103(a) as being unpatentable over Agarwala et al. (U.S. 5,376,584) in view of Yi et al. (U.S. 6,348,730).

Claim 18 was rejected under 35 U.S.C.§103(a) as being unpatentable over Agarwala et al. (U.S. Patent No. 5,376,584) in view of Yi et al. (U.S. Patent No. 6,348,730 B1) as applied to claim 17 above, and further in view of Microelectronics Packaging Handbook, Semiconductor Packaging, Part II, 2nd edition, Tummala et al. eds., Kluwer Academic Publishers: Boston, 1997, pp. 132-139.

## 7. ARGUMENT

The contentions of Appellant with respect to the issue presented for review in the foregoing Item 6 and the basis therefor, with citations of the authorities, statutes, and parts of the record relied on, (as required by 37 CFR §1.1 92(c)(8)), are provided as follows, with each issue being treated under a separate heading.

For each rejection under 35 USC § 103, Appellant's argument specifies (as required by 37 CFR 41.37(c)(1)(vii)) the errors in the rejection and why the rejected claims are patentable under 35 USC §103, including any specific limitations in the rejected claims which are not described in the prior art relied upon in the rejection.

All descriptions of Appellant's disclosed and claimed embodiments, and all descriptions and rebuttal arguments regarding the applied references, as previously submitted by Appellant in any form, are repeated and incorporated herein by reference. Further, all Office Action statements regarding the objections and rejections are respectfully traversed. Further, Appellant submits the following.

### A) The Applicable Law

"A patent may not be obtained...if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art." 35 U.S.C. § 103(a).

A determination of the obviousness or nonobviousness of claimed subject matter is a legal conclusion based on several factual inquiries. These include determining the scope and content of the prior art, ascertaining the differences between the prior art and the claims at issue, and resolving the level of ordinary skill in the pertinent art. *Graham v. John Deere Co.,* 148 USPQ 459, 467 (1966); *Winner International Royalty Corp. v. Wang*, 53 USPQ2d 1580, 1586 (Fed. Cir. 2000).

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the

reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (M.P.E.P. § 2143 8th Ed, Rev.1).

In ascertaining the differences between the prior art and the claims, courts are required to consider the claimed invention as a whole. *Panduit Corp. v. Dennison Mfg. Co.*, 1 USPQ2d 1593, 1597 (Fed. Cir. 1987). It is impermissible to use the claimed invention as a "template" to piece together the teachings of the prior art to render the claimed invention obvious. *In re Fritch*, 23 USPQ2d 1780, 1784 (Fed. Cir. 1992). The claims must be interpreted in light of the specification, claim language, other claims, and prosecution history. *Panduit,* 1 USPQ2d at 1597. A §103 reference must also be considered in its entirety, "including portions that would lead away from the invention." *Id.* A court must consider not only the similarities, but also the "critical differences between the claimed invention and the prior art." *In re Bond*, 15 USPQ2d 1566, 1568 (Fed. Cir. 1990).

In establishing obviousness, two or more references each containing elements of the claimed invention may be combined, provided all the recited claim elements are met and that there is a suggestion, teaching or motivation to combine the references. *In re Dembiczak,* 50 USPQ2d 1614, 1617 (Fed. Cir. 1999). Further, even if the prior art provides such a suggestion, motivation or teaching, there must be a reasonable expectation of success for the suggested combination. *In re Vaeck*, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991).

**B) ARGUMENT: Claims 17-19, 21, 23, and 25 are Patentable over the Cited References under 35 USC §103 because a Prima Facie Case of Obviousness has not been Established.**

*§103 Rejection of the Claims*

Claims 17, 19, 21, 23 and 25 were rejected under 35 USC § 103(a) as being unpatentable over Agarwala et al. (U.S. 5,376,584) in view of Yi et al. (U.S. 6,348,730).

Claim 17 requires the limitations of forming

> ... a refractory metal first layer over the metallization
> ... a refractory metal second layer over the first layer
> ... a refractory metal third layer above and on the refractory metal second layer ... [and]
> ... a refractory metal fourth layer above and on the refractory metal third layer ....

**The specific limitations in the rejected claims are not described in the cited references relied on in the rejection.**

The combination of Agarwalla with Yi does not teach all the limitations of claim 17. The Examiner admitted "Agarwala '584 does not indicate the nature of a phased metal layer ... that the phased metal layer [24] includes a first and third layers of substantially the same metal and the second and fourth metals of substantially the same metal." (Office Action at page 5). The Examiner looked to Yi '730 to remedy this deficiency. The Examiner's statements regarding the teachings of Yi, however, are in error.

Firstly, Yi teaches copper in connection with chromium. Copper is not a refractory metal, nor has it been characterized as such by Applicant. Agarwalla adds nothing to remedy this deficiency. Because all the claim limitations are not taught in the combined references, Appellant respectfully requests overturning of the rejections.

Secondly, Yi's teaching at column 3, lines 5-14 states in pertinent part,

> a first metal layer, a third metal layer and a phased layer therebetween. The phased layer includes second and fourth metal layers made of the same material as the first and third metal layers, respectively . . . .

(Yi at column 3, lines 5-14). Yi's second and fourth metal layers are necessarily the same as Yi's first and third metal layers, respectively. In Yi, this means chromium on chromium and copper on copper, and this cannot be construed to teach the limitations of

Appellant's claim 17. Yi's teaching is verified in Yi's FIGs. 9 and 10. For example, Yi invariably teaches Cr 51, which is Yi's "first metal layer", touches only Cr 151, which is Yi's "second metal layer" and Cu 55, which is Yi's "third metal layer", touches only Cu 155, which is Yi's "fourth metal layer". The scheme of first touching second and being the same metal, and fourth touching third and being the same metal, also applies to FIG. 10. Yi's naming of metal layers is semi-arbitrary. Although Yi's names: "first", "second", "fourth", and "third" are normally used as sequentials, Yi's third metal layer 55 is last in sequence of four metals, and consequently Yi's "third" metal layer is the fourth in sequence.

Thirdly, Yi teaches more particularly that when "layer" is set forth, what is particularly meant is multiple layers of the same type, namely

> *in further detail*, eight chrome layers 151, two copper layers 155, seven chrome layers 151, three copper layers 155, six chrome layers 151, four copper layers 155, five chrome layers 151, five copper layers 155, four chrome layers 151, six copper layers 155, three chrome layers 151, seven copper layers 155, two chrome layers 151, eight copper layers 155, are *deposited in sequence*.

(Yi at column 4, lines 42-49, emphases added). Consequently, Yi teaches some 70 metal layers are formed in a sequence, but never "alternating layers of two different metals" as characterized by the Examiner.

There is therefore no combination of Agarwalla with Yi that teaches all the limitations of claim 17. Appellant respectfully requests overturning of the rejections.

**Because the specific limitations in the rejected claims are not described in the cited references relied on in the rejection, these limitations render claim 17 unobvious over Yi in view of Agarwalla.** The Examiner incorrectly construed Yi's fourth metal layer 155 (Cu) to be above and on Yi's third metal layer 55 (Cu), where it was asserted Yi's fourth metal layer 155 (Cu) was substantially the same metal as Yi's second metal layer 151 (Cr). Appellant respectfully requests that the Board overturn the Examiner's rejection.

When one applies the teaching of Yi to Agarwalla, one does not reach what is claimed. Further, the motivation to combine Yi with Agarwalla, in view of what they actually teach, comes only from Appellant's disclosure. Appellant respectfully requests that the Board overturn the Examiner's rejection.

**The cited references taken as a whole do not suggest the claimed subject matter.**

The Examiner at page 7, further mischaracterized Yi's teachings by referring to sequences "first, third, fifth, etc. metal layer (each designated as 151) . . . and second, fourth, sixth, etc. metal layer (each designated as 155) to be of the same metal." (Office Action at page 7). But this is not correct. As set forth above, Yi teaches sequentially first, second, fourth, and third metal layers, and invariably only in that order. Further, Yi invariably teaches the third metal layer 55 is above and on the fourth metal layer 155, which is contrary to what is claimed in claim 17. Appellant respectfully requests that the Board overturn the rejection.

It was errantly asserted that "Yi teaches that a *phased metal layer is composed of alternating layers of two different metals* and consequently explains to one of ordinary skill what the phased metal layer of Agarwalla is likely to look like and how it may be made." (Office Action at pages 6 and 7, emphasis added). Yi never teaches "alternating layers of two different metals" (Office Action at page 6). Yi teaches in great detail, several layers of identical metal, alternated by several layers of a different metal. (Yi at column 4, lines 42-49, *supra*).

The Examiner also characterized these 70 or so metal layers of Yi as single metal layers of alternating chromium and copper. (Office Action at page 7). This assertion is in error and should be overturned. As set forth above, Yi teaches, e.g. one of the structures includes "eight chrome layers 151, two copper layers 155" *etc.* The Examiner erroneously asserted that Yi means a single metal layer is composed of laminates, only to

> determine the thickness of the layer (either 151 or 155) and are accordingly a single layers (sic) of metal *of varying thickness* as Yi states at col. 4, lines 37-42,
>
> 'The chrome layers 151 get thinner from the chrome layer 51 toward the

> copper layer 55, while the copper layers 155 get thicker from the chrome layer 51 toward copper layer 55.'

(Office action at page 7). Incidentally, even Yi's statement is at variance with Yi's FIG. 9. The copper layers 155 indeed begin to increase in number and to become as composites, increasingly thicker structures. For example, tracking upwardly toward copper layer 55, Yi teaches two layers 155, three layers 155, four layers 155, and five layers 155. But then the copper layers 155 begin to decrease in number and to become, as composites, increasingly thinner structures. Continuing to track upwardly from the five layers 155, Yi's composite copper layers include four layers 155, three layers 155, and two layers 155 below and on the copper layer 55. Appellant respectfully requests that the Board overturn the Examiner's rejection.

The assertion was made that "the individual laminates with a given layer, 151 or 155, are not shown to change thickness." (Office Action at page 7). But too fine a point has been put on this assertion since Yi does not mention anything to support it. Further, an actual comparison of the thicknesses of each of Yi's top two layers 155, to each of Yi's bottom two layers 155 reveals that the top layers are approximately 33% thicker. Although Appellant does not consider this to be material to the Examiner's failure to establish a prima facie case of obviousness, Appellant has discussed this assertion to show the Examiner's unsupported assertions.

The Examiner next asserted "Yi does teach that the third metal layer is in direct contact with the second metal layer and the that fourth metal layer is in direct contact with the third, etcetera, in any phased metal layer." (Office Action at pages 7 and 8). This mischaracterization of what Yi teaches has been dealt with above, and the rejection should be overturned.

The Examiner concluded with a recitation of some limitations of claim 17, in particular asserting "Applicant appears to be arguing a limitation absent in Yi which is not presently claimed." (Office Action at page 8). As set forth above, Appellant respectfully asserts Yi teaches a feature that does not match the limitation of claim 17. Appellant

respectfully requests that the Board overturn the Examiner's rejection.

Because the cited references when combined, do not teach or suggest all the claim limitations, Appellant respectfully requests that the Board overturn the Examiner's rejection.

Appellant notes that claims 19, 21, 23, and 25 depend from claim 17 and include other limitations that make them separately patentable over claim 17. The combined teachings of Agarwala '584 with Yi, fail to teach all the limitations of these claims as set forth above. Because the cited references when combined, do not teach or suggest all the claims' limitations, Appellant respectfully requests that the Board overturn the Examiner's rejection.

Claim 18 was rejected under 35 U.S.C.§103(a) as being unpatentable over Agarwala et al. (U.S. Patent No. 5,376,584) in view of Yi et al. (U.S. Patent No. 6,348,730 B1) as applied to claim 17 above, and further in view of Microelectronics Packaging Handbook, Semiconductor Packaging, Part II, 2nd edition, Tummala et al. eds., Kluwer Academic Publishers: Boston, 1997, pp. 132-139. Appellant respectfully traverses the rejection and requests the Board to consider the following.

The deficiencies of Agarwala '584 and Yi as set forth above are incorporated herein by reference. The Examiner cited to Tummala et al. eds., to teach "that it is notoriously well known (1) for the bonding pad to be copper (p. 137, last paragraph, and Fig. 8-6 on p. 138), as well as (2) for the bond pad to attach to one of the metallization layers (the third metallization layer as shown in Fig. 8-2, on p. 133). Tummala illustrates a no-bond pad metallization; the 2.3 micron Al-4% Cu is in direct contact with a Cr layer. Because all the claim limitations are not taught by the cited references, Appellant respectfully requests that the Board overturn the Examiner's rejection.

Referring again to the rejection of claim 18, Appellant notes that Tummala et al., does nothing to remedy the failure of Agarwala '584 and Yi to teach what is claimed in claim 17, from which claim 18 depends.

Because the cited references when combined, do not teach or suggest all the claim limitations, Appellant respectfully requests that the Board overturn the Examiner's

rejection.

For the foregoing reasons, Appellant respectfully submits that the rejection of the claims on appeal was erroneous. Appellant earnestly requests the Board to overturn the Examiner's final rejections.

## 8. SUMMARY

It is respectfully submitted that no *prima facie* case of obviousness in claims 17-19, 21, 23, and 25 under 35 U.S.C. §103(a), has been established by the Office. Therefore, it is respectfully requested that the rejections of claims 17-19, 21, 23, and 25 be reconsidered and withdrawn. The Appellants respectfully submit that all of the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone the Appellants' attorney, John Greaves at (801) 278-9171, or the undersigned attorney to facilitate prosecution of this Application. If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

CURTIS E. JUTZI ET AL.

By their Representatives,

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Date May 16, 2005 By Ann M. McCrackin
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John D. Gustav-Wrathall
Name

Signature

## CLAIMS APPENDIX

1-16. (Canceled)

17. (Previously Presented) A process comprising:

forming a metallization;

forming a refractory metal first layer over the metallization;

forming a refractory metal second layer over the refractory metal first layer;

forming a refractory metal third layer above and on the refractory metal second layer, wherein the refractory metal third layer is substantially the same metal as the refractory metal first layer;

forming a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal second layer; and

forming an electrically connective bump above the refractory metal fourth layer.

18. (Original) The process according to claim 17, wherein forming a metallization comprises:

forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (M1) to M6.

19. (Original) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

depositing the refractory metal first layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce.

20. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å.

21. (Original) The process according to claim 17, wherein forming a refractory metal second layer over the refractory metal first layer comprises:

depositing the refractory metal second layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, NiV, CoV, PdV, PtV, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce in a solid-solution or stoichiometric ratio.

22. (Withdrawn) The process according to claim 17, wherein forming a refractory metal second layer over the refractory metal first layer comprises:

sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

23. (Original) The process according to claim 17, wherein forming a refractory metal third layer over the metallization comprises: depositing the refractory metal third layer by physical vapor deposition.

24. (Withdrawn) The process according to claim 17, wherein forming a refractory metal third layer over the metallization comprises:

sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å.

25. (Original) The process according to claim 17, wherein forming a refractory metal fourth layer over the refractory metal first layer comprises:

depositing the refractory metal fourth layer by physical vapor deposition.

26. (Withdrawn) The process according to claim 17, wherein forming a refractory metal fourth layer over the refractory metal first layer comprises:

sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

27. (Withdrawn) A process comprising:

forming a metallization;

sputtering a refractory metal first layer over the metallization;

sputtering a refractory metal second layer over the refractory metal first layer, wherein the refractory metal second layer is a refractory metal alloy;

sputtering a refractory metal third layer above and on the refractory metal second layer, wherein the third refractory metal is substantially the same metal as the refractory metal first layer;

sputtering a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal first layer; and

plating a Sn-containing solder through a mask onto the refractory metal fourth layer to form an electrically connective bump.

28. (Withdrawn) The process according to claim 27, further comprising:

etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder; and

reflowing the solder.

29. (Withdrawn) The process according to claim 27, further comprising

first anisotropic etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder;

second isotropic etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder and to the mask; and

reflowing the solder.

30. (Withdrawn) The process according to claim 27, further comprising:

anisotropically etching the mask and the first-through-fourth refractory metal layers by using the bump precursor as a shadow mask; and

etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder.

31. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

32. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, and wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å.

33. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal fourth layer over the refractory metal first layer includes sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

34. (Withdrawn) The process according to claim 17, wherein forming a metallization includes:

forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (M1) to M6; and

wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal fourth layer over the refractory metal first layer includes sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

35. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units.

36. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, and wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units.

37. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units, and wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 of the arbirtary units to about 2,000 of the arbirtary units.

38. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 of the arbirtary units to about 2,000 of the arbirtary units, and wherein forming a refractory metal fourth

layer over the refractory metal first layer includes sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 of the arbitrary units to about 4,000 of the arbitrary units.

39. (Withdrawn) The process according to claim 17, further including:

nitriding at least one of the metal second layer and the metal fourth layer to form a nitrided metal alloy or a nitrided vanadium-doped metal.

40. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack.

41. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

electroless plating a bump precursor over the four-metal-layer stack.

42. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack; and

further processing the four-metal-layer stack to remove the four-metal-layer stack except under the bump precursor.

43. (Withdrawn) A process comprising:

forming a metallization;

forming a Ti first layer over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units;

forming a NiV second layer over the Ti first layer to a thickness in a range from about 1,000 of the arbitary units to about 4,000 of the arbitary units;

forming a Ti third layer over the NiV second layer to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units; and

forming a NiV fourth layer over the Ti third layer to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units.

44. (Withdrawn) The process according to claim 43, wherein the Ti first layer, the NiV second layer, the Ti third layer, and the NiV fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack; and

further processing the four-metal-layer stack to remove the four-metal-layer stack except under the bump precursor.

45. (Withdrawn) The process according to claim 43, further including:

plating a Sn-containing solder through a mask onto the NiV fourth layer to form an electrically connective bump;

etching the first-through-fourth layers with an etch recipe that is selective to the solder; and

reflowing the solder.

## EVIDENCE APPENDIX

None.

## RELATED PROCEEDINGS APPENDIX

No Related Proceedings are known to the Appellants' Representative.